CLAIMS

WHAT IS CLAIMED IS:

1. An apparatus comprising:

(a) an injection mold having one or more portions;

(b) a gas supply tube containing a gas at a first pressure;

(c) an orifice member having an orifice thereon in thermal communication with at least one portion of the injection mold, wherein the orifice member is operably coupled to receive the gas from the gas supply tube, and wherein the orifice member is adapted to release the gas from the gas supply tube through the orifice; and

(d) a gas exhaust channel containing the gas at a second pressure, wherein the gas exhaust channel is operably coupled to receive the gas from the orifice member, and wherein the second pressure is lower than the first pressure;

whereby at least one portion of the mold is cooled.

2. The apparatus of Claim 1 wherein the gas includes air.

3. The apparatus of Claim 1 wherein at least a portion of the gas supply tube is cylindrical.

4. The apparatus of Claim 1 wherein at least a portion of the gas exhaust channel is cylindrical.

5. The apparatus of Claim 1 wherein at least a portion of the gas supply tube is surrounded by the exhaust channel.

6. The apparatus of Claim 1 wherein at least a portion of the gas supply tube is surrounded by an insulating jacket.

7. The apparatus of Claim 1 wherein the gas exhaust channel includes a bore portion having a closed distal end located within the injection mold, wherein the gas supply tube includes a pipe portion with an end having at least one orifice member, and wherein at least a portion of the end of the pipe portion of the gas supply tube is positioned in thermal contact with the closed distal end of the bore portion of the gas exhaust channel.

8. The apparatus of Claim 1 wherein the gas exhaust channel includes a bore portion having a closed distal end located within the injection mold, wherein the gas supply tube includes a pipe portion with an end having at least one orifice member, and wherein at least a portion of the end of the pipe portion of the gas supply tube is positioned adjacent to the closed distal end of the bore portion of the exhaust channel.

9. The apparatus of Claim 1 wherein the gas exhaust channel includes a bore portion, wherein the gas supply tube includes a bore portion, and wherein the orifice member has a first side operably coupled to the bore portion of the gas supply tube and a second side operably coupled to the bore portion of the gas exhaust channel.

10. The apparatus of Claim 1 further comprising a gas supply system operably coupled to supply the gas at the first pressure to the gas supply tube, and wherein the gas supply system includes at least one gas cooler adapted to cool the supply of gas at the first pressure.

11. The apparatus of Claim 1 further comprising a gas supply system operably coupled to supply the gas at the first pressure to the gas supply tube, and wherein the gas supply system includes at least one gas compressor.

12. The apparatus of Claim 1 further comprising a gas supply system operably coupled to supply the gas at the first pressure to the gas supply tube, and wherein the gas supply system can be operated to adjust the flow rate of the gas at the first pressure between a non-zero flow rate and a flow rate which is essentially zero.

13. The apparatus of Claim 1 further comprising a gas supply system operably coupled to supply the gas at the first pressure to the gas supply tube, and wherein the gas supply system can be operated to adjust the flow rate of the gas at the first pressure to two or more non-zero flow rates.

14. The apparatus of Claim 1 further comprising a gas supply system operably coupled to supply the gas at the first pressure to the gas supply tube, and wherein the gas supply system can be operated to adjust the magnitude of the pressure of the gas at the first pressure.

15. The apparatus of Claim 1 further comprising a gas supply system operably coupled to supply the gas at the first pressure to the gas supply tube wherein the gas supply system can be operated to adjust the magnitude of the pressure of the gas at the first pressure, and a controller operably coupled to operate the gas supply system.

16. The apparatus of Claim 1 further comprising a gas supply system operably coupled to supply the gas at the first pressure to

the gas supply tube wherein the gas supply system can be operated to adjust the flow rate of the gas at the first pressure, and a controller operably coupled to operate the gas supply system.

17. The apparatus of Claim 1 further comprising a gas supply system operably coupled to supply the gas at the first pressure to the gas supply tube wherein the gas supply system can be operated to adjust the flow rate of the gas at the first pressure, a temperature sensor adapted to measure the temperature of at least one portion of the injection mold and to produce at least one temperature signal, and a controller operably coupled to receive the at least one temperature signal from the temperature sensor and operably coupled to operate the gas supply system.

18. The apparatus of Claim 1 further comprising a gas supply system operably coupled to supply the gas at the first pressure to the gas supply tube wherein the gas supply system can be operated to adjust the magnitude of the pressure of the gas at the first pressure, a temperature sensor adapted to measure the temperature of at least one portion of the injection mold and to produce at least one temperature signal, and a controller operably coupled to receive the at least one temperature signal from the temperature sensor and operably coupled to operate the gas supply system.

19. The apparatus of Claim 1 further comprising a gas exhaust system operably coupled to receive the gas at the second pressure from the gas exhaust channel, and wherein the gas exhaust system can be operated to adjust the magnitude of the pressure of the gas at the second pressure.

20. The apparatus of Claim 1 further comprising a gas exhaust system operably coupled to receive the gas at the second pressure from the gas exhaust channel wherein the gas exhaust system can be operated to adjust the magnitude of the pressure of the gas at the second pressure, and a controller operably coupled to operate the gas exhaust system.

21. The apparatus of Claim 1 further comprising a gas exhaust system operably coupled to receive the gas at the second pressure from the gas exhaust channel wherein the gas exhaust system can be operated to adjust the magnitude of the pressure of the gas at the second pressure, a temperature sensor adapted to measure the temperature of at least one portion of the injection mold and to produce at least one temperature signal, and a controller operably coupled to receive the at least one temperature signal from the temperature sensor and operably coupled to operate the gas exhaust system.

22. The apparatus of Claim 1 further comprising a gas exhaust valve operably coupled to receive the gas at the second pressure from the gas exhaust channel.

23. The apparatus of Claim 1 further comprising a gas supply system operably coupled to supply the gas at the first pressure to the gas supply tube and a gas exhaust system operatively coupled to receive the gas at the second pressure from the gas exhaust channel, wherein the gas supply system is operably coupled to receive the gas at the second pressure from the gas exhaust system.

24. The apparatus of Claim 1 wherein at least a portion of the orifice member is in thermal contact with the at least one portion of the injection mold, thereby providing thermal communication between the orifice member and the at least one portion of the injection mold.

25. The apparatus of Claim 1 wherein at least a portion of the gas released from the orifice member strikes the at least one portion of the injection mold, thereby cooling the at least one portion of the injection mold.

26. The apparatus of Claim 1 further comprising a thermally conductive member, wherein at least a portion of the thermally conductive member is in thermal contact with at least a portion of the orifice member, and wherein at least a portion of the thermally conductive member is in thermal contact with the at least one portion of the injection mold, thereby cooling the at least one portion of the injection mold.

27. The apparatus of Claim 1 further comprising a thermally conductive member, wherein at least a portion of the gas released from the orifice member strikes at least a portion of the thermally conductive member, and wherein at least a portion of the thermally conductive member is in thermal contact with the at least one portion of the injection mold, thereby cooling the at least one portion of the injection mold.

28. The apparatus of Claim 1 further comprising a gas supply valve, wherein the gas supply tube is operably coupled to receive the gas at the first pressure from the gas supply valve.

29. The apparatus of Claim 28 wherein the gas supply valve can be operated to adjust the flow rate of the gas at the first pressure between a non-zero flow rate and a flow rate which is essentially zero.

30. A method of cooling a portion of an injection mold comprising the steps of:

(a) providing an orifice member having a first side and a second side, wherein the orifice member is in thermal communication with a portion of an injection mold;

(b) supplying a gas at a first pressure to the first side of the orifice member; and

(c) providing a gas exhaust channel containing the gas at a second pressure on the second side of the orifice member, wherein the second pressure is lower than the first pressure; and

(d) releasing the gas from the first side of the orifice member through the orifice member to the second side of the orifice member into the gas exhaust channel,

thereby cooling the portion of the injection mold.

31. The method of Claim 30 wherein the gas includes air.

32. The method of Claim 30 further comprising the step of adjusting the magnitude of the pressure of the gas supplied on the first side of the orifice member.

33. The method of Claim 30 further comprising the step of adjusting the magnitude of the pressure of the gas in the gas exhaust channel.

34. The method of Claim 30 further comprising the step of providing a gas supply valve operably coupled to the first side of the orifice member for adjusting the flow rate of the gas supplied on the first side of the orifice member.

35. The method of Claim 30 further comprising the step of providing a gas exhaust valve operably coupled to the gas exhaust channel for adjusting the flow rate of the gas in the gas exhaust channel.

36. The method of Claim 30 further comprising the steps of measuring the temperature of at least one portion of the injection mold and adjusting the magnitude of the pressure of the gas supplied on the first side of the orifice member.

37. The method of Claim 30 further comprising the steps of measuring the temperature of at least one portion of the injection mold and adjusting the magnitude of the pressure of the gas in the gas exhaust channel.

38. The method of Claim 30 further comprising the steps of measuring the temperature of at least one portion of the injection mold and adjusting the flow rate of the gas supplied on the first side of the orifice member.

39. The method of Claim 30 further comprising the steps of measuring the temperature of at least one portion of the injection mold and adjusting the flow rate of the gas in the gas exhaust channel.

40. A method of cooling a portion of an injection mold comprising the steps of:

(a) providing a gas supply tube containing a gas at a pressure above atmospheric pressure;

(b) providing an orifice member having a first side operably coupled to the gas supply tube and a second side containing the gas at a pressure no greater than atmospheric pressure, wherein the orifice member is in thermal communication with a portion of an injection mold; and

(c) releasing the gas from the first side of the orifice member through the orifice member to the second side of the orifice member,

thereby cooling the portion of the injection mold.

41. The method of Claim 40 further comprising the step of adjusting the magnitude of the pressure of the gas in the gas supply tube.

42. The method of Claim 40 further comprising the step of adjusting the flow of the gas through the gas supply tube.

43. The method of Claim 40 further comprising the steps of measuring the temperature of at least one portion of the injection mold and adjusting the magnitude of the pressure of the gas in the gas supply tube.

44. The method of Claim 40 further comprising the steps of measuring the temperature of at least one portion of the injection mold and adjusting the flow of the gas through the gas supply tube.

45. The method of Claim 40 wherein the orifice member has one or more apertures comprising an orifice having an effective size,

and further comprising the step of adjusting the effective size of the orifice.

46. The method of Claim 40 wherein the orifice member has one or more apertures comprising an orifice having an effective size, and further comprising the steps of measuring the temperature of at least one portion of the injection mold and adjusting the effective size of the orifice.

47. An apparatus comprising:

(a) an injection mold having one or more portions;

(b) a pipe containing a gas at a first pressure and having at least one orifice member in thermal communication with at least one portion of the injection mold; and

(c) a bore in the injection mold at least partially surrounding the orifice member and containing the gas at a second pressure, wherein the second pressure is no higher than the first pressure;

whereby the release of gas from the pipe through the orifice member into the bore cools the at least one portion of the injection mold.

48. The apparatus of Claim 47 wherein the bore has a distal end at least partially surrounded by the injection mold, wherein the pipe has an end at least partially surrounded by the distal end of the bore, and wherein the orifice member is located at the end of the pipe.

49. The apparatus of Claim 47 wherein the gas includes air.

50. An orifice assembly for cooling an injection mold, comprising:

(a) a pipe having a first end, a second end, and a midpoint along its length;

(b) an orifice member located at the second end of the pipe; and

(c) an insulating jacket extending from a point between the first end of the pipe and the midpoint of the pipe to a point between the midpoint of the pipe and the second end of the pipe.

51. The orifice assembly of Claim 50 wherein the orifice member includes a disk having one or more holes whose combined cross-sectional area is less than 50% of the cross-sectional area of the second end of the pipe.

52. The orifice assembly of Claim 50 wherein the orifice member includes a porous plug having a plurality of pores, wherein the combined area of the pores is less than 50% of the cross-sectional area of the second end of the pipe.

53. The orifice assembly of Claim 50 further comprising an exhaust channel having a closed end, wherein the second end of the pipe has a peripheral edge, and at least a portion of the peripheral edge of the second end of the pipe is in thermal contact with the closed end of the exhaust channel.

54. The orifice assembly of Claim 53 wherein the peripheral edge of the second end of the pipe includes at least one notch.

55. The orifice assembly of Claim 53 wherein the second end of the pipe has one or more sides, and wherein the pipe includes at

least one hole in a side of the second end of the pipe adjacent to the peripheral edge.